

Application No. 10/809,385
Amendment under 37 CFR 1.111
Reply to Office Action dated November 3, 2005
May 3, 2006

AMENDMENTS TO THE SPECIFICATION

Please substitute the paragraph beginning at page 1, line 4 and ending at line 11 to read as follows:

-- The present invention ~~relaters~~ relates to a performance input apparatus provided with an operating section displaceable about one or more axes, and more particularly to a technique of imparting the displaceable operating section with a virtual reactive force responsive to input operation (input operating force), by a human operator, of the operating section. For example, the performance input apparatus of the present invention is suitable for use as input apparatus of electronic musical instruments, as well as input apparatus for various games, computer-aided designing (CAD), etc. --

Please substitute the paragraph beginning at page 6, line 1 and ending at line 27 to read as follows:

-- Fig. 1 is a perspective view showing an example of an outer appearance of the performance input apparatus 1, which generally comprises an operating section 2, a base section 3 and

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a junction section 4 connecting the operating section 2 and base section 3 so that the junction section 4 allows the operating section 2 to be displaced relative to the base section 3. The operating section 2 is movable or displaceable in three directions depicted by double-headed arrows A, B and C in response to operation by a human operator. The operating section 2 includes a rod-shaped main shaft 5 (i.e., an operating arm) extending along ~~a Z~~ an X axis, a grip portion 6 provided at one end of the main shaft 5 for gripping by the human operator, and a stopper 7 provided at the other end of the main shaft 5. The base section 3, which extends along a Y axis, generally comprises two pipe-shaped shafts, i.e. reference shaft 8 (i.e., an arm portion) and free shaft ~~[[108]]~~ 10 (i.e., a free arm). Overall length of the base section 3 is adjustable. The reference shaft 8 has a reference ball 9 (generally ball-shaped portion) provided at its one (i.e., distal) end, and the free shaft 10 has a free ball 11 (generally ball-shaped portion) provided at its one (i.e., distal) end. The junction section 4 includes a center controller 12 of a generally spherical shape, through which the main shaft 5 of the operating section 2 extends for movement or displacement in the arrow A direction. The junction section 4 also includes a frame or gimbal ring 13 rotatably supporting the

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center controller 12. On the outer periphery of the gimbal ring 13, there are provided a support portion 14 supporting the above-mentioned reference shaft 8, and a mounting portion 15 having the free shaft 10 secured thereto. Thus, there is provided a multi-axis movement mechanism (i.e., the junction section 4) that allows the operating section 2 to be displaced relative to the base section 3 with respect to a plurality of axes. --

Please substitute the paragraph beginning at page 9, line 11 and ending at page 10, line 5 to read as follows:

-- Now briefly explaining a manner in which the performance input apparatus 1 is operated by the human operator, the input apparatus 1 is normally used in a positionally fixed condition with the reference ball 9 of the reference shaft 8 held by the human operator, or by being placed on the ground surface, or otherwise. With the reference ball 9 of the performance input apparatus 1 fixed at a predetermined position, the operating section 2 and center controller 12 are displaced relative to the base section 3 and junction section 4 (gimbal ring 13) in response to operation, by the human operator, of the operating section 2. For example, the human operator can fix the

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performance input apparatus 1 at a predetermined position by gripping the reference ball 9 with one hand and holding the free ball 11 between the chin and a portion of the shoulder near the neck, under which conditions the human operator can manipulate the operating section 2 by holding the grip portion 6 with the other hand. Alternatively, the performance input apparatus 1 may be positionally fixed with the reference ball 9 placed on the ground surface like a contra bass and the free ball 11 or free shaft 10 gripped with one hand, in which case too the human operator can manipulate the operating section 2 by holding the grip portion 6 with the other hand. The performance input apparatus 1 may be held in a positionally fixed state in any other suitable manner. Because the base section 3 is adjustable in its overall length as noted above, it can be adjusted to any desired length in accordance with the manner in which the input apparatus 1 is held, or in accordance with user's convenience. --

Please substitute the paragraph beginning at page 10, line 22 and ending at page 11, line 17 to read as follows:

-- The sensor sections 30 - 32 provided in corresponding relation to the pivot axes X, Y and Z may comprise rotational

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position sensors capable of detecting respective rotational positions, about the corresponding pivot axes, of the operating section 2. Detection data of the rotational position sensor sections 30 - 32 are output as position information, for the pivot axes X, Y and Z, of the operating section 2 (i.e., "position information X", "position information Y" and "position information Z"). Differentiating the detection data of the rotational position sensor sections 30 - 32 can determine operating velocity (speed) and acceleration of the operating section 2. Namely, even where the sensor sections 30 - 32 are in the form of rotational position sensors, the performance input section 1 can be arranged to detect displacement of the operating section 2 for desired displacement-related parameters, such as a position, velocity, acceleration, angle, etc. In one implementation, each of the sensor sections 30 - 32 may be arranged to detect a displacement-related parameter different from those allocated to the other sensor sections; namely, a displacement-related parameter to be detected by each of the sensor sections 30 - 32 may be defined independently of the other sensor sections. For example, the X-axis sensor section 30 position information, the Y-axis sensor section 31 velocity information, and the Z-axis sensor section 32 acceleration

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information. Note that the sensor sections 30 - 32 may be in the forms of velocity or acceleration sensors, rather than position sensors, for detecting operating velocity or acceleration. Further, an operating position of the operating section 2 may be determined by integrating the velocity detected by the velocity sensor. --

Please substitute the paragraph beginning at page 14, line 13 and ending at line 28 to read as follows:

-- The motor section [[40]] 41 is driven to cause the gear 60 to pivot, which in turn causes the spur gear 61 to pivot, and such pivotal movement of the spur gear 61 turns the reference shaft 8. Because the reference shaft 8 is secured at its one end 8a to the gimbal ring 13 as illustrated in Fig. 2, the pivoting force acting on the reference shaft 8 is transmitted to the gimbal ring 13. As noted above, the gimbal ring 13 supports the center controller 12 via the connecting portions 16a and 16b and pivotal movement, about the Y pivot axis, of the gimbal ring 13 is transmitted to the center controller 12, so that the center controller 12 pivots about the Y axis together with the gimbal ring 13, i.e. in response to driving of the Y-axis motor section

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41. Therefore, the operating section 2 is imparted with a pivoting force about the Y axis in response to the pivoting force applied to the center controller 12. In this way, a reactive force can be imparted, via the Y-axis pivot section 21, to the operating section 2 in the arrow B direction, by driving the motor section 41 about the pivot axis Y' to thereby apply to the center controller 12 a pivoting force about the Y axis. --

Please substitute the paragraph beginning at page 17, line 11 and ending at line 25 to read as follows:

-- Fig. 5 is a block diagram showing an example of an overall hardware setup of the performance input apparatus 1. As shown, the performance input apparatus 1 includes a CPU 100 for controlling behavior of the apparatus 1, a RAM 102 used as a working memory etc., a parameter table 103, a parameter controller 104, an input/output interface (I/F) 105, etc. and these components are interconnected via a communication bus 106. Interface 107 is provided for receiving outputs from the X-axis, Y-axis and Z-axis sensor sections 30, 31 and 32 in a time-division multiplexing manner. Each of the sensor outputs received via the interface 107 is converted by an A/D converter

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108 into a digital signal, which is then supplied via the communication bus 106 to the CPU 100. To a driver 109 is connected an actuator 110 for driving the X-axis, Y-axis and Z-axis motor sections 40, 41 and 42. Whereas the actuator 110 is shown in Fig. [[2]] 5 as a single block, it may be constructed by combining three one-dimensional actuators for driving the respective motor sections 40 - 42. --

Please substitute the paragraph beginning at page 21, line 9 and ending at line 22 to read as follows:

-- Now, a description will be given about primary control processing performed by the CPU 100 in the performance input apparatus 1 arranged in the above-described manner. As outputs of the X-, Y- and Z-axis sensor section 30 - 32, corresponding to operating positions on the individual axes, are supplied to the CPU 100, the CPU 100 performs a process for detecting the operating positions of the operating section 2 on the individual axes, on the basis of the supplied sensor outputs, per predetermined clock timing. Then, with reference to the parameter table 103, the CPU 100 calculates values of performance parameters, such as a tone pitch, volume and color, each

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corresponding to any one or any combination of the operating position, velocity and acceleration of each of the axes or combination of the outputs for a plurality of the axes. Then, the CPU 100 performs a tone signal generation process to cause the tone generator [[13]] 113 to generate a tone signal on the basis of the calculated performance parameters. --

Please substitute the paragraph beginning at page 22, line 27 and ending at page 23, line 24 to read as follows:

-- Then, on the basis of the supplied X-, Y- and Z-axis reactive force information, the CPU [[1]] 100 generates drive signals for driving the actuator 110 which correspond to the X, Y and Z pivot axes. The thus-generated drive signals are supplied via the D/A converter 111 to the driver 109, which in turns drives the actuator 110 in a controlled manner, as noted above. Specifically, the drive signals, corresponding to the X, Y and Z pivot axes, are supplied to the driver 109 time-divisionally among the pivot axes to which the pieces of reactive forces are to be imparted, in accordance with which the actuator 110 drives the X-, Y- and Z-axis motor sections 40, 41 and 42 in a controlled manner on a time-divisional basis so that the X-, Y-

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and Z-axis pivot sections 20, 21 and 22 impart the operating section 2 with respective reactive forces about the pivot axes X, Y and Z. In this way, reactive forces can be produced and imparted to the operating section 2 in the directions of arrow A, arrow B and arrow C (see Fig. 1) in response to operating states, in the three directions, of the operating section 2. Because the reactive forces to be imparted in correspondence with the three pivot axes are variable in accordance with the operating states (three parameters of an operating position, velocity and acceleration), there can be produced reactive forces responsive to not only variation in the operating position of the operating section 2 but also variation over time (i.e., temporal variation) of the operating section 2. The parameters (i.e., parameters to be input to the touch data table) to be used for calculation of the reactive force need not necessarily be all of the above-mentioned three parameters; at least any one of the operating position, velocity and acceleration parameters may be used for calculation of the reactive force. Further, angle, pressure and/or other information may be used in addition to the above-mentioned parameters. --

Please substitute the paragraph beginning at page 25, line

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11 and ending at page 26, line 23 to read as follows:

-- As the operating section 200 is operated in the arrow A direction, the slide gear mechanism 93a, meshing with the gear tooth portion 200a, is pivoted in accordance with an amount of the linear displacement, in the arrow A direction, of the operating section 200. The X-axis pivot section 201 detects the pivotal movement of the gear mechanism 93a so that an operating position, in the arrow A direction, of the operating section 200 can be detected on the basis of the detected pivoted position of the gear mechanism 93a. On the other hand, as the X-axis motor contained in the X-axis pivot section 201 is driven, the slide gear mechanism 93a is pivoted, and this pivotal movement of the gear mechanism 93a is transformed via the gear tooth portion 200a into a linear drive force opposite in direction to the operation, in the arrow A direction, of the operating section 200. In this way, a reactive force can be imparted to the operating section 200 in the arrow A direction (i.e., reactive force in a forward or rearward direction as viewed by the human operator). As the operating section 200 is operated in the arrow C direction, pivotal movement, about the Z pivot axis, of the operating section 200 acts on all of the components on the Z-axis base

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section 92 via the guide section 90. The Z-axis pivot section 203 detects a pivoted position of the Z-axis base section 92, functioning as a supporting point of the pivotal movement, so that an operating position, in the arrow C direction, of the operating section 200 can be detected on the basis of the detected pivoted position of the base section 92. On the other hand, as the Z-axis pivot section 203 is driven to make pivotal movement, the pivotal movement about the Z pivot axis is transmitted to and acts on all of the components on the Z-axis base section 92 with the Z-axis base section 92 functioning as a supporting point of the pivotal movement. In this way, a reactive force opposite in direction to the operation, in the arrow C direction, of the operating section 200 can be imparted to the operating section 200 (i.e., pivotal movement in a leftward or rightward direction as viewed by the human operator). Furthermore, as the operating section 200 is operated in the arrow B direction, the guide section 90 is caused to pivot about the Y pivot axis with the bearing portion of the Y-axis base section 91 functioning as a supporting point of the pivotal movement. The Y-axis pivot section ~~201~~ 202 detects a pivoted position of the guide section 90, so that an operating position, in the arrow B direction, of the operating section 200 can be

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detected on the basis of the detected pivoted position of the guide section 90. On the other hand, as the Y-axis pivot section 202 is driven to pivot, the pivotal movement about the Y pivot axis is transmitted to and acts on the guide section 90. In this way, a reactive force opposite in direction to the operation, in the arrow B direction, of the operating section 200 can be imparted to the operating section 200 (i.e., reactive force in an upward or downward direction as viewed by the human operator). --